



**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
**National Marine Fisheries Service**  
**166 Water Street**  
**Woods Hole, MA 02543**

April 3, 2002

## CRUISE RESULTS

NOAA Fisheries Research Vessel DELAWARE II  
Cruise DE 02-01 (Parts I – II)

Small Pelagics Hydroacoustic Survey

## CRUISE PERIOD AND AREA

The 2002 Small Pelagics Hydroacoustic Survey was conducted during two parts between February 19 and March 8, 2002. Part I was conducted during February 19 - 28 on the continental shelf (between the 40 and 400 m bathymetric contours) in the mid-Atlantic (between 38° and 42° N). Part II was conducted during March 4 - 8 on the continental shelf (between the 40 and 400 m bathymetric contours) in Southern New England (between 39° 30' and 42° N).

## OBJECTIVES

Cruise objectives were to (1) calibrate the 18, 38, and 120 kHz EK500 echosounder systems, (2) conduct acoustic surveys of Atlantic mackerel (*Scomber scombrus*), and Atlantic herring (*Clupea harengus*) stocks in the mid-Atlantic region to provide fisheries independent abundance estimates, (3) ground-truth species-specific acoustic estimates using mid-water trawls and underwater video, (5) conduct *in-situ* multi-frequency target strength (TS) experiments on herring and mackerel.

## METHODS

Survey operations included continuous data collection along a series of systematic transects using the Simrad EK500 echosounder operating at 18, 38, and 120 kHz and Scientific Computer System (SCS) throughout the cruise track and during gear deployments. Systematic surveys were conducted in the mid-Atlantic region on the continental shelf between the 40 and 400 m bathymetric contours. Midwater trawling and CTD deployments were routinely conducted to identify acoustic backscatter and obtain biological and oceanographic data. Biological and oceanographic samples were collected and processed according to standard NEFSC procedures. EK500 acoustic data were routinely processed at sea using the Echoview post-processor.

Transect and deployment times, locations, and other information were recorded with the SCS eventlogger throughout the cruise.

### Survey Design:

Systematic evenly spaced transect surveys were designed for Parts I and II. Transects (lengths and distances between transects) were chosen to cover the bathymetric features on the continental shelf. Transect spacing was 10 nautical miles (nmi). During Part I, transects were oriented East-West between the 40 m and 400 m bathymetric contours. The 40 m contour was chosen as the High Speed Midwater Trawl (HSMRT) trawl can not be deployed in depths shallower than 50 m. The offshore extent of the survey was delineated by the 400 m contour to include the continental shelf. Each transect was sequentially numbered and defined as a continuous cruise track with a single heading and constant ship speed. Parallel transects were defined as a series of parallel coordinated vessel tracks within a specified area. Cross-over transects were tracks perpendicular to parallel transects for traveling between parallel transects, and were generally not used for abundance estimates. When deployments occurred during a transect, the previous transect number was resumed if the vessel continued along the track at approximately the same location and heading of the previous transect. If the vessel heading changed or the vessel did not resume near the end of the previous track, the transect number was incremented. Vessel speed during all surveys was designated at 10 knots, and actual survey speeds ranged from 8-12 knots depending on weather conditions and currents.

### EK500 Calibration:

The multifrequency Simrad EK500 (v.5.30) Scientific Sounder system was the primary instrumentation used to estimate the abundance of small pelagic species. The FRV Delaware's EK500 operated three downward looking hull-mounted transducers (split-beam 18, 38, and 120 kHz). For each frequency, a calibration sphere of known target strength was suspended under each transducer. Each sphere was moved throughout the acoustic beam using three remotely controlled downriggers. Amplitude measurements using the "Test" setting (system self-calibration) were recorded to verify that the EK500 system was working properly.

### EK500 Operations

The primary acoustic data used for population estimates of small pelagics were collected with the Simrad EK500 scientific echosounder (v.5.30) operating three hull mounted transducers (18, 38, and 120 kHz split-beam transducers). The three frequencies were transmitted simultaneously at a ping rate of one ping per two seconds. The EK500 was operated continuously throughout the cruise. Volume backscatter ( $S_v$  [ $\text{m}^2/\text{m}^3$ ]) data were collected to a depth of 500 m at 1 m vertical resolution (500 depth intervals), and higher resolution data (10 cm vertical resolution) were collected 10 m above the bottom. Volume backscatter, GPS, time, and individual Target Strength (TS) values were logged for each ping to a shipboard PC using SonarData's EchoLog software package.

During the cruise, volume backscatter echograms were post-processed to remove unwanted noise (e.g., surface bubbles, acoustic or electronic interference, and echoes from the bottom) and partition acoustic backscatter to species or scattering type. Acoustic data were collected using a volume backscatter threshold of -90 dB, and an individual TS threshold of -66 dB. For post-processing, a volume backscattering threshold of -66 dB was applied. Data for all three frequencies were post-processed and apportioned to species or scattering category while at sea based on midwater trawl catches, target strength distributions, and backscattering patterns. Volume backscatter was vertically integrated from a specified depth below the surface (“bubble layer”) to 0.5 m above the bottom. Data between the surface and the bubble layer were not included in the analysis to eliminate scattering by surface bubbles and noise. The bubble layer was set to 10 m for the 38 and 120 kHz data, and 12 m for the 18 kHz. At the completion of the cruise, the data and post-processing files were downloaded to a shore-based computer at the NEFSC for archival and further analysis.

#### High Speed Midwater Rope Trawl (HSMRT) Sampling Operations:

The High Speed Midwater Rope Trawl (HSMRT, Gourock design R2028825A) was the main sampling gear used to verify fish backscatter. The mouth opening of the HSMRT was approximately  $13 \pm 3$  m vertical and  $27 \pm 5$  m horizontal, and 600 lb tomweights were used. HSMRT deployments were targeted on selected fish backscatter along the cruise track. Deployments served to verify species composition comprising acoustic backscatter. The HSMRT was towed at an average speed of 4.5 knots typically for 30 minutes in duration. However, tow duration often varied between 10 to 40 minutes depending on acoustic patterns observed during the tow. Tow duration was defined as the time between setting the doors and when doors were hauled out of the water. The tow profile of the trawl was typically dropped incrementally through the water column to the desired depth of the scattering layer or about 10 m off the bottom, held at that depth for the duration depending on the fish targets observed by the trawl monitoring system, and then retrieved back to the surface. Trawl duration, tow depths, and tow speeds were not standardized or consistent between trawls and catch data should not be used for abundance estimates.

#### Midwater Trawl Monitoring:

Trawl performance was measured with a FS903 system, ITI system, and a pair of Vemco temperature-depth Minilog sensors. The Simrad FS903 Trawl Monitoring System was a third-wire device that provided real-time sonar images of the trawl opening and performance. The FS903 sonar display was also used to monitor whether fish went into or around the trawl opening, and allowed the tow duration to be optimized to capture only the necessary amount of fish required for scientific samples. The Simrad ITI wireless trawl sensors were used to obtain point measurements of the trawl depth, wing spread, and door spread. Trawl mensuration measurements were manually recorded on log sheets at 5-10 minute intervals. Minilog depth-temperature probes were attached to the trawl headrope and footrope to provide continuous depth-temperature and trawl performance profile data for each deployment.

### Biological Sampling:

The catch from each trawl was sorted by species, weighed, and measured (fork length to the nearest cm) according to standard NEFSC procedures. The catches were input to the Fisheries Scientific Computer System (FSCS) and then downloaded to an Oracle database at the conclusion of each trawl. These data were downloaded to the NEFSC for further audits and archive.

### Scientific Computer System (SCS):

The FRV Delaware's Scientific Computer System (SCS) continuously collected navigational, oceanographic, and meteorological data at a rate of every 10 seconds throughout the cruise. These data were archived on CD-ROM's and shore-based computers at NEFSC. Navigational data were used to produce cruise track images (*e.g.*, Figures 1 and 2).

The SCS Event Logger program was used throughout the cruise to develop a detailed eventlog file of start and end points of times and positions of each transect and deployment. The eventlog also contained operational and observational comments and was critical for managing and linking our continuous and deployment data. All computers, instrumentation, acoustic data collection, and data recording were synchronized according to the SCS master clock and time was recorded in GMT. The event log was manually audited to correct errors, downloaded to a shore-based computer at the NEFSC for archive and imported to the fisheries acoustics Oracle database.

### Other Data:

Conductivity-temperature-depth (CTD) casts were conducted throughout the cruise, at the transect nodes and immediately prior to gear deployments. These data are maintained and archived by the Fisheries Oceanography Investigation (FOI) at the NEFSC. After the FOI audits these data, they were downloaded to an Oracle database at the NEFSC.

## RESULTS

Calibrations of the EK500 38 and 120 kHz systems were successfully completed dockside along the Woods Hole Oceanographic Institution (WHOI) pier on February 19. Target Strength (TS) and volume scattering (Sv) gains were derived using the Simrad Lobe (v.95-01-17) program. The TS and Sv gains for the 38 kHz were modified from 23.00 dB to 23.15 dB (TS) and from 22.90 dB to 22.95 dB (Sv). The TS gain for the 120 kHz was modified from 25.80 dB to 25.90 dB, whereas the 120 kHz Sv gain remained constant (25.80 dB). The 18 kHz was calibrated on Feb. 23 in approximately 30 m of water. The 18 kHz transducer was installed during the recent dry-dock period, and this was our first calibration of this system. The TS and Sv gains were modified from the default value of 23.00 dB to 23.25 (TS) and 23.40 (Sv) dB.

### Part I Operations:

The FRV Delaware departed Woods Hole, MA on February 20 at 1700 (all times herein are GMT) and steamed south towards Block Island Sound to calibrate the 18 kHz. An attempt was made to calibrate the 18 kHz on February 20, but due to wind and currents, the calibration was unsuccessful. The FRV then steamed south to commence the systematic parallel transect survey. During the survey, the 18 kHz was successfully calibrated on February 24. During Part I, 28 transects (14 parallel, 13 cross-over, and 1 steaming transect), 29 CTD casts, and four midwater trawls were conducted (Figure 1). The parallel transects covered the area from 38° 00' N to 41° 00' N between the 40 and 400 m bathymetric contours on the continental shelf. Water temperature on the shelf was typically about 8° C, with 6° C water nearshore (<60 m bottom depth). Acoustic backscatter in the pelagic regions of the continental shelf was low. Elevated backscatter occurred nearshore (<60 m bottom depth) and near the shelf-break. We were unable to verify species composition of the nearshore aggregations, but were able to trawl near the shelf break. Two tows were conducted near the shelf-break and one tow was conducted in Hudson Canyon, where lanternfish, pearlsides, large salps, and loligo squid comprised the bulk of the catch. During Part I, midwater trawls catches were very low. Due to winds and sea states, four parallel transects at the northern end of the survey were not completed. The FRV Delaware collected data on the northernmost transect, and then halted operations near Long Island. With continued high winds and sea-state, all operations were halted and the FRV Delaware arrived in Woods Hole, MA on February 28 at 18:30.

### Part II Operations:

The start of Part II was delayed from March 2 to March 4 due to high winds and sea state. The FRV departed Woods Hole at 1930 on March 4, and steamed south. The survey design for Part II was a series of systematic parallel transects oriented north-south (Figure 2). During Part II, nine CTD casts and two midwater trawls were conducted. 15 transects (eight parallel, six crossover, and one steaming) were completed during Part II. Due to high winds and sea state, the FRV steamed into Long Island Sound at 2200 on March 6 to conduct an *ad hoc* survey. This survey consisted of two parallel transects oriented along the axis of the sound (Figure 2). On March 7 at 1130 we resumed our transects in Southern New England. Due to the sea swell, the final transect was not parallel to the previous transects (*i.e.*, a heading was chosen to reduce vessel motion). The first midwater trawl was conducted in approximately 60 m water depth. The catch consisted of Atlantic herring, Atlantic mackerel, spiny dogfish, searobins, and loligo squid. The second midwater trawl was conducted near the shelf-break, and the catch was comprised of loligo squid and silver hake.

### Overview

The cruise was successful for implementing modifications to the SCS event logging program, networking the fisheries acoustics scientific computers to the ships network, and calibrating the EK500. The cruise was unsuccessful for surveying Atlantic mackerel and Atlantic herring. The paucity of pelagic targets detected by the EK500 on the continental shelf during this cruise

suggests that this may not be an optimal time or place to survey for Atlantic mackerel. A suggested modification to assess Atlantic mackerel may be to conduct surveys during their northward migration during April.

Aggregations of clupeid-type fish were commonly detected by the EK500 in water shallower than approximately 60 m where water temperatures were less than 7° C. To minimize net avoidance by fast swimming fish like mackerel, the HSMRT was designed for maximum tow speeds (up to 5 knots) and mouth opening (approximately 350 m<sup>2</sup>) based on the FRV Delaware's fishing capabilities. However, the size of the trawl restricts deployment to depths less than 50 m. Although smaller trawls have avoidance problems, it would be beneficial to implement the use of a second pelagic trawl of smaller dimensions to verify species composition in depths less than 50 m. Another possibility for verifying acoustic targets and obtaining biological information in shallow water is to utilize a second vessel equipped with a smaller pelagic or bottom trawl.

#### DISPOSITION OF DATA

All data and results are archived at the Northeast Fisheries Science Center. Audited data and results can be obtained from the Fisheries Acoustic Research Group at the Northeast Fisheries Science Center in Woods Hole, MA.

## SCIENTIFIC PERSONNEL

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Part I	February 19 - March 1, 2002
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Part II	March 4 - 8, 2002
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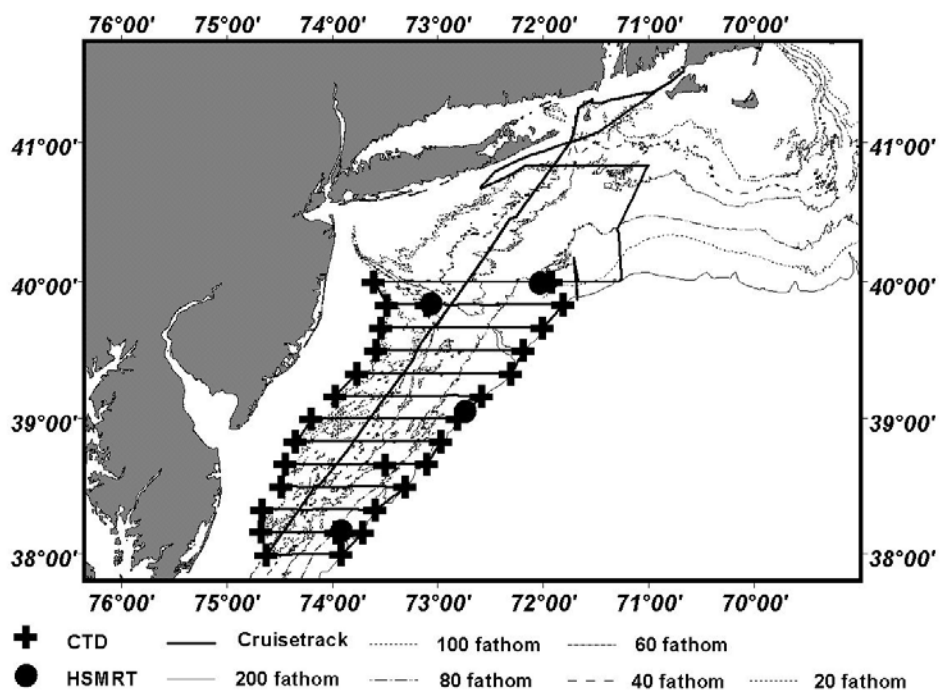


Figure 1. Cruise track and deployment locations for Part I, DE200201, February 19 - 28, 2002.

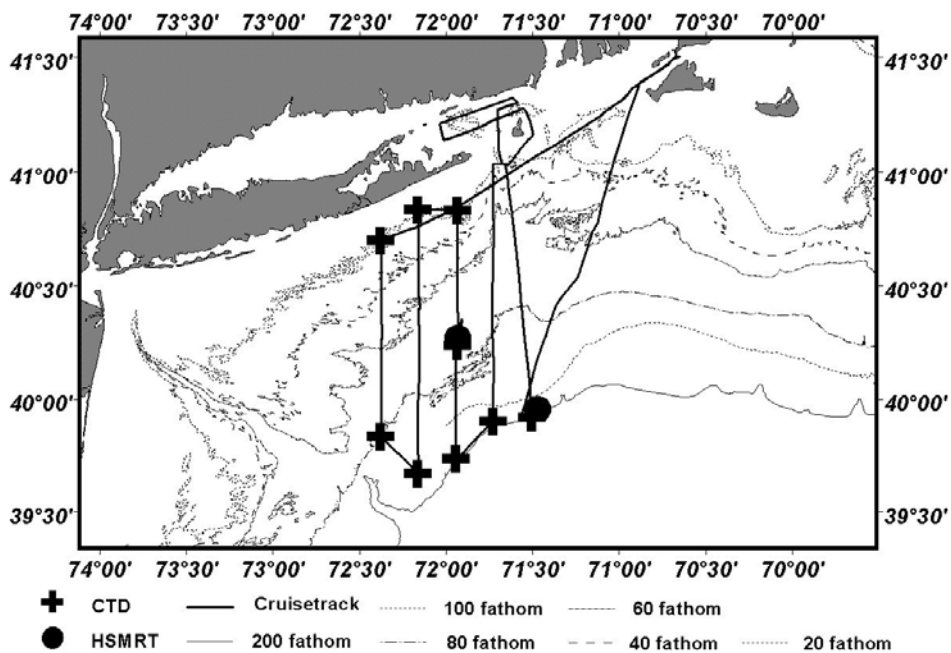


Figure 2. Cruise track and deployment locations for Part II, DE200201, March 4 - 8, 2002.

2. Cruise